Data Collection and Analysis Lab - Mr. Ward - 8-20-03

LESSON 1 - Using the Vernier Caliper

1. Examine your Vernier caliper. It can measure to tenths of a millimeter.

2. You can open and close the movable jaw by rolling the wheel with your thumb.

3. To learn how to use the Vernier caliper, click on "Vernier Caliper Simulation" on the lab page. http://www.physicscoach.com/labs03 (This simulation is taken from the following website which does not appear to be copyrighted: http://webphysics.ph.msstate.edu/jc/library/1-4/)

4. Make sure there is NOT a check in the "show" box. (The "show" box is for physics wimps.) Click and drag the movable jaw on the simulation about ¼ of the way open. See if you can determine the reading in millimeters and tenths.

5. Type the value of your reading in the box at the top of the simulation. Then hit <u>Enter</u> on your keyboard. If you are correct, it will tell you.

6. If you are WRONG it will tell you by how much you missed. For example, if the correct answer is 14.7 and you said 11.3, it will say you are off by –3.4. Try to figure why your answer is wrong.

7. If you are wrong, move the jaw in the simulation to a new location and try another reading. Check your answer.

8. If you are totally mystified, click on the "show" box. Move the lower jaw around and watch how the reading changes. If you still can't figure it out, ask for help, preferably from another nearby student.

9. You need to learn these <u>two</u> things today: **(1)** how to get the number before the decimal (whole millimeters) and **(2)** how to get the number after the decimal (tenths of a millimeter).

10. Once you think you see the trick, turn the "show" box off and test yourself on at least five (5) different settings. EACH lab partner should be able to do this on his own. You WILL be quizzed on this SOON using pictures similar to the simulation.

11. You can move back and forth between Word and the Vernier Simulation by clicking the boxes at the very bottom of the screen. When you are finished with the simulation, you may close it by clicking on the X in its upper right hand corner or by clicking on the Back arrow in the MSIE browser.

Taking Circle Data

12. On a sheet of paper, make a neat data table with four columns and space below for sixteen rows of data. The first column should be headed “number”, the second “diameter (mm)”, and the third “diameter (cm), and the fourth “circumference (cm)”. Number the first column from 0 to 16. (We are going to count the “zero” circle, too. This circle has no diameter and no circumference.)

13. The lab partner should watch what the other partner is doing. DO NOT divide the job and each do half. Each partner should either do the measurement or observe the measurement. Take turns measuring. You MUST double-check each other. Scientists check each other’s work and so should you.

14. Each lab partner must hand in his own data table. If there is an error, don’t tell me, “I didn’t make that measurement. My partner must have messed up.” NO. If you write down a value, you are telling me you either made it or checked it.

15. Using the Vernier caliper, measure the diameter of each circle, starting with the smallest, and record it in mm (and tenths) on the appropriate line in the second column. Larger rings are measured differently from smaller ones. Figure this out. (Remember, the diameter is the LARGEST chord!) Make sure you measure on a smooth part of the ring. Some rings have bumps. Avoid those. Record the diameter in cm and hundredths in the third column. Be careful you convert correctly!

16. After you have measured all sixteen circles, take the piece of paper tape and wrap it tightly around one of the rings so the tape overlaps one end of the tape. If there is a bump on the ring, do not wrap the tape over it. Do not wrap more than one layer. Place a sharp pencil mark where the end of the tape is overlapped.

17. Unwind the tape and lay it on a meterstick. Measure the length to the pencil mark in cm (and tenths and hundredths) and record it in the fourth column. It is best to start measuring at the 10 cm mark (why?) and then subtract 10 cm from the answer you get. You should carefully estimate the circumference to the nearest hundredth of a cm or tenth of a mm. For example, 13.42 cm instead of 13.4 cm. Yes, you CAN and must do this.

18. When you are finished measuring, KEEP the paper tape. Fold it and put it in one of your notebooks or folders. You may need to check a measurement.

Guidelines for Graphing by Hand in PENCIL

Click “Graph Paper Website” (http://www.mathematicshelpcentral.com/graph_paper.htm) on the lab page. Print up a sheet of “**Form5A-BW.pdf**.” Also download “Graph Paper Printer Program” onto the desktop of your laptop.

19. Determine which variable is independent and which is dependent (and on which axis you want each). Talk it over with others if you are not sure.

20. Decide the orientation of the graph paper: portrait or landscape. Your choice on this graph.

21. Place your origin in the lower left corner.

22. Draw your horizontal and vertical axes using a PENCIL and a straight edge.

23. Find the range of values to be graphed for both the dependent and independent variables. That is, your diameters may range from 0 to 15 cm and your circumferences from 0 to 50 cm.

24. Count the squares along each axis, starting at your origin and going to the edge.

25. Divide the maximum independent value (from step 23) to be graphed by the number of blocks along the horizontal axis. (Horizontal means left-right! The floor is horizontal.) Write this number down in your notes.

26. Divide the maximum dependent value (from step 23) to be graphed by the number of blocks along the vertical axis. (Vertical means up-down! Walls are vertical.) Write this number down in your notes.

27. Round each of these values per block up to the next available value of the type 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500. Don't use values such as 3, 4, 6, 7, 8, 9, 11, 12, 13, etc. Write these TWO numbers down in your notes. Each of your blocks is worth that value along each axis.

28. Starting at the origin, put a small hash mark every 2 or 5 blocks along the axes and number them outside the graph. Remember what each block is worth from step 27. Do <u>not</u> mark and number every block!

29. Label the axes, <u>with</u> <u>words</u>, not just symbols, below the numbers, centered on the axes. Label the vertical axis so it can be read by rotating the graph 90^{o} clockwise. Also include the independent and dependent unit abbreviations in parentheses. That is, "Diameter (cm)".

30. Plot the pairs of data. Use a straight edge or corner of a paper to locate points if needed. DO NOT write the coordinates on the graph.

31. Determine by sighting along the line whether the relationship is linear or not.

32. If it is linear, draw the line using a straight edge so that it comes as close to as many points as possible. Do not force it to go through the origin unless (0,0) is a known data point.

33. If the data is non-linear, draw the line using short, light arcs, which come near about three data points at a time. When finished, draw a smooth curve that has no sharp corners.

34. If required, make the graph linear by modifying the values along one of the axes by the appropriate method.

35. Find the slope by taking two points, far apart, on the curve. If the straight line goes through the origin, use (0,0) as one of the points. If neither one nor two points are on the line, add one or two "data" points on the line. Mark them so you will know they are artificial. Use one or both to find the slope of the line.

36. Find the equation for the straight line, if present, by using $y = mx + b$ and substituting your values for y, m, x, and b. If $b = 0$, just use the $y = mx$ form.

37. The equation for the curve should be written along the curve.

38. Place the figure number and the title in an open space on the graph along with your name and date. Each lab partner must hand in his own data table and his own graph. Do that when you are finished.

After this lesson: You should be able to: (1) measure to nearest 0.1 mm using Vernier caliper; (2) find the independent and dependent variable(s) in an experiment; (3) graph by hand; (4) find the slope and equation of the line.